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Interactive comment on "Evaluation of the IGS–Global Ionospheric Mapping model over Egypt" *by* Mostafa Rabah and Ahmed Sedeek

Anonymous Referee #3

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General remarks

According to the title, article investigate ionosphere over Egypt. Approximately longitude of Egypt is in the range 22-32°N, but the result in the paper are obtained only for the 30-32°N region. It would be better to mark this in the title (e.g. writing "Northern Egypt"). The other problem of the title is that it gives insufficient information about the paper content. Reading the title one can think that the paper describes analysis of models used in IGS from GIM calculation. It is still not clear from the article what do you mean by "IGS-Global Ionosphere Mapping model" mentioned in the title. Please specify it in the text. I think the title should also show that you investigate improvement of precise positioning method based on usage of ZDPID algorithm and TTC 2.7 software.

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[Discussion paper]

Authors do not describe what laboratory GIM data is used in study. Such a description is absolutely necessary because of differences between existing GIMs, especially taking into account the paper conclusion (lines 386-388). It should also be explained why do authors prefer used data to the others.

One of the most important parts of the study is the algorithm of Zero-differenced phase Ionospheric Delay (ZDPID) calculation. The presented reference cites the paper not published yet. This almost-published article was also cited in the another paper of the authors in IJSER (http://www.ijser.in/archives/v6i4/IJSER172374.pdf). I would recommend to describe the algorithm in the current paper in more details. I also would strongly recommend not to cite articles which are not published.

The article mentioned above also contains a part of the results from the current paper. Authors should add corresponding references to all the previously obtained results (especially to figures (see fig. 10)). Both the articles (current and in IJSER) investigate ionosphere during April 15, 2015. Average KP index value during 15.04.2015 reached 5, so the geomagnetic conditions were disturbed. Authors should explain why did they choose this day. Moreover, the results for a single day are not allow to make solid conclusion about method effectiveness or GIM uselessness. Presenting the same results of GIM modification for other days will make a basis for the conclusion.

Being labeled "Results and discussion" section 4 contains no discussion. The obtained results are important and should be discussed. I think authors should give some explanation of presented dynamics of ZDPID TEC values, dynamics of station position before and after ModIONEX usage and all the statistical quantities they obtained.

Current conclusion gives nothing for understanding the paper results. All the listed statement are not good. First statement is not derived from the paper because the results of GIM-based positioning was not presented. The fact that changed IONEX usage effect on station coordinates show that GIM values play role. It should be shown that there is no difference, but not just claimed. Second statement is just a general

description. I think it should present some quantitative values to show that ZDPID algorithm gives good corrections for all the stations. Third statement have no ground. The only place in the article where the listed software is discussed is this part of the conclusion. If authors really obtained such a result they should present how did the do that.

Text corrections

line 7: Are all the GIMs generated in CODE?

line 8: where did you get the number 400? Description in CODE file (codg1050.15i) reports about 300 stations (268 in header), number of stations in IGS file (igsg1050.15i) is 323.

line 10: "to cover these holes" repeats line 12

line 33: "2 hours" - since 2015 CODG provide the maps with the resolution of 1 h

lines 38-39: difficult to read. Reformulate please.

line 43: All the GIM maps have this resolution, not only from IGS.

lines 58-60: I would specify accuracy values to enhance the statement. Anyway it is not clear why do you say it here.

lines 61-62: Could you list several models?

line 62: "low temporal ans spatial resolutions". What do you mean by low resolution. Could you specify it with quantities? The same for "low accuracy" in line 63.

lines 62-63: Do you mean Li-Pi combination by "carrier phase-smoothed pseudor-ange"? Specify that because in line 72 you are saying that carrier phase gives precise positioning and that is confusing.

line 65: Choose one: el/m^2 or e/m^2 (as in line 165)

line 75: El-Hattab et al., 2003 – is it a misprint (in References year is 2001)?

line 83: "As is known" - Can you add a reference to the corresponding paper?

line 86: "correct ionospheric correction" - bad formulation

line 119: What do you mean by "long baseline"? Could you give some range for the value or make a comparison? The same thing for short (line 126) and medium (line 131) baselines.

line 131: Satellite elevation angles?

line 142: I would replace "amount" by "value"

lines 147-148: TECU value was defined previously in line 65.

line 157: You define $L_4(t)$ and φ_{GF} here, but do not use them below. Do you really need them and what L4(t) should mean? In GNSS studies L usually stands for phase advance but this is the only place where you use it.

line 160: add space in "L1frequency"

lines 163 – 165: Is it a definition of Single Layer Model? If so, you should highlight that. It is not obvious now.

line 174: Add a numeration if it is a subsection, else remove it. Actually, being entitled as "Mapping function model" the subsection gives no information about F(E). It describes a well-known procedure of IPP coordinates calculation. Why do you give this here? And where is the mapping function model?

lines 183-184: the same phrase "Ionospheric pierce point (IPP)". Please remove one.

lines 178, 186 and 216: I don't really think it is necessary to define IPP position calculation equations especially citing your own paper. There are plenty of work about it before 2017 (e.g. Klobuchar, J. (1987) Ionospheric Time-Delay Algorithms for Single-Frequency GPS Users. IEEE Transactions on Aerospace and Electronic Systems, AES-23, 325-331. http://dx.doi.org/10.1109/TAES.1987.310829)

line 180: Azimuth is a positively-defined quantity. I would add $\pi/2$ to A value.

line 187: As far as I understand, according to the fig (2): angle ψ = E' - E. In your article (Sedeek et al. 2017) it was defined this way.

line 192: Why do you take ionosphere height to be 450 km? Usual value is about 300-350 km in accordance with altitude of F2 maximum.

line 198: what do you mean by "enhance ambiguity resolution"?

line 200: Misprinted IONEX

line 201: Does SW mean software, space weather, solar wind or something else?

line 202: misprint "different lengths"

line 202: What do you mean by "ion TEC"? What is the difference with TEC and how do you get it?

lines 229-230: "Processing" was used trice. Please reformulate

lines 240 and 254-255: This table is not necessary. You are not using its data at all. I recommend to remove it.

lines 245-247: You claim this with no evidence. This statement should be proven.

line 248: Again, what do you mean by "Ion TEC"?

lines 257-258: The algorithm should be described in more details. I strongly recommend not to cite articles not published yet.

line 258: describe the GPS phase ambiguity resolution model in more details.

line 261: "for the aforementioned stations": you mentioned 7 stations, but according to table 2 and figure (4) data for only 5 of them was used. If so, I would recommend to remove unused stations from both figure (3) and description in lines 217-221.

line 264: Values from which GIM map and what node of it do you use here? Table

(3) allow me to consider that the node is located at (32.5°N, 30°E). Even in case of values from (30°N, 30°E) most stations are quite far from the node. Don't you think the approximated values should be used here?

lines 263-264: Differences between ZDPID TEC from stations are more dramatical than between ones and GIM values. Station ALEX being located between SAID and MNSR gives huge TEC. Could it be connected with another receiver in ALEX? The figure (4) should be discussed in much more details.

lines 273-274: "derived" used twice; "useless for use" is a bad formulation

line 347: It is better to replace second "Figures 7,8,9 and 10" by "The figures"

lines 352-356: This sentence ought to split and reformulate.

Figures, tables and formulas

Figure (2). What is marked by A? It should not be azimuth, but you do not discuss this in text. Either define it, or remove from the figure. Height H can not be defined as you shown, it should radial. Aspect ratio is distorted. Please remake the figure.

Figure (3). Increase the figure resolution. It would be useful to mark here GIM node position which was used to obtain TEC data. Most eastern point in figure is named Port Saeed, whereas in text its name is Port Said. Chose one name and use it.

Figure (5). The text should be removed from the figure to text. The only useful part of the figure is upper right, so remove all the others.

Figure (6). All the flow char is made roughly, blocks are placed uneven. Text in block "Compute..." is partially hidden. Block with electrons per meter to TECU calculation looks quite useless. Right column blocks contains a lot of empty space.

Table (3). The table consists of there identical blocks with the single number changed. Taking into account that all the values are presented in figure (4) this table could be removed at all.

Quality of figs. 7-10 is unacceptable. Obviously, the figures are resized with aspect ration distortion. Labels and legends are difficult to read. The data presented in the figures are not discussed and the only useful part here is in the tables. I recommend remove plots and use numbers from tables to make good visual picture of the dynamics of max, min, max and RMS values before and after ModIONEX usage. It should be noted, that some data is already published in IJSER.

All the formulas should be the same style and in a good resolution. Now forms (1-4), (5) and others (lines 168 – 169 and 180-194) have absolutely different format. The numeration should be added everywhere (as for 1-4) or removed from all the formulas (as in lines 180-194).

Not all the abbreviations used in the paper are introduced properly. (numbers stands for lines):

Used before or with no introduction: IGS(8), GNSS(11), IONEX (15), TEC(38), CODE(7), JPL(39), TECU(42), ESA (46), UPC (46), NRCan(46), STEC (53), IPP (165), ECEF (176), CSRS (338)

Reintroduced: GIM(7, 14, 29, 41, 387), SHE(9, 32, 47, 66), TECU (65, 148), IPP (183, 184), TTC(201, 229), ZDPID (257, 390)

Introduced, but not used: MSLM(38), AC(45), SLM(69, 167), TEC_P and TEC_φ(151)

Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2018-92, 2018.